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(54) Correction of band-like print non-uniformities in a thermal printing system

(57) Heating elements of a thermal head are controlled by means of image data such that each element is heated to approximately the same surface temperature.

The actual surface temperature in each element is measured and correction values are calculated on the basis of the measured surface temperature values.

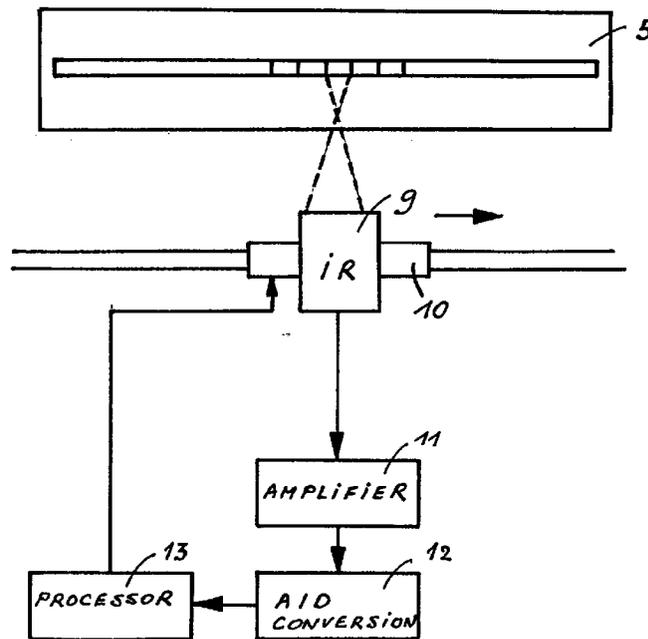


Fig. 2

## Description

### Field of the invention.

The present invention relates to thermal printing methods and, in particular, to the improvement of the print uniformity of a print produced by a thermal printing head.

### Description of the prior art

It is known, and put to intensive commercial use, to prepare both black-and-white and coloured half-tone images by the use of a thermal printing head, a heat-sensitive receiving material or a combination of a heat-sensitive donor material and a receiving (or acceptor) material, and a transport device which moves the receiving material or the donor-acceptor combination relative to the thermal printing head. The thermal head usually consists of a one-dimensional array of heating elements arranged on a ceramic base which is itself mounted on a heat-dissipating base element. Systems of this kind generally do not reproduce original images that are uniformly coloured over their area, in a uniform colour shade, but additionally produce defects particularly in the form of streaks or bands perpendicular to the extension of the head. There is a multiplicity of possible causes of this, and there is a corresponding diversity in the number of published methods for eliminating these streak-like or band-shaped print non-uniformities.

Examples of such causes are i.a. inequality of the values of the resistors of the thermal head, variations in the thickness of the layers the thermal head is composed of, fluctuations of the coefficient of conductivity, variations of the thermal efficiency per pixel etc.

US Patent 4,827,279 of Anthony R. Lubinsky et al., entitled "Process for Correcting Across-the-head Nonuniformity in Thermal Printers", describes a correcting method, in which a transparent receiving material is printed with a uniformly coloured field by activating all the heating elements of the thermal head by means of the same input data. According to this disclosure, the receiving material thus printed is measured by a microdensitometer, and the measurement data thereby obtained are compared with the desired value. The deviations from this desired value, which are averaged over a sufficiently long distance in the direction of transport of the receiving material, are used to calculate a correction value for each individual heating element of the thermal head. During all the subsequent prints, the primary uncorrected control data for the thermal head are changed by the amount of these correction values specific to the heating elements and are only then transmitted to the control of the thermal head.

European Patent EP 0,627,319 of Eric Kaerts and Paul Verzele, entitled "Method for Correcting Across-the-head Unevenness in a Thermal Printer", likewise describes a correction method based on density meas-

urement values which have been obtained on a test print. In contrast to US 4,827,279, however, this test print is not produced by applying the same electrical control signal to all the heating elements, but by converting the same electrical power as a time average in all the heating elements. For this purpose, in a preceding step, the electrical resistance of each heating element is measured. The deviations of the measured optical density from the desired value, which are averaged in the direction of transport of the receiving material, are then used again to calculate a set of correction values for each heating element which, in turn, serves again for correcting each primary data record of control data of a print output of the thermal printing system. By the use of the "power-compensated control data" instead of uncorrected control data both in the determination of the density correction factors and during each printing operation, the uniformity of the print results is improved even further.

Nevertheless, the result is not always satisfactory. This is true, in particular, in the case of image recordings on a transparent receiving material that are used in medical diagnostics, in which optical density values to about 3 are required and in which the radiologist is accustomed to appraise these radiographic images visually when they are suspended in front of a light box. In this case, even slightly pronounced bands, for example with a swing corresponding to a density difference of 0.02, are still felt to be troublesome and make medical diagnosis more difficult. A particular cause of these streaks which still remain despite these corrections is that the correction method cannot differentiate between differences in the print result as a consequence of element-to-element differences in the head and those as a consequence of non-uniformities and faults in the receiving material used for the test print. Consequently, variations in the print result, which had an effect only once, namely during the production of the test print, are erroneously assumed to continue to be indicated for the subsequent prints and are "corrected". That is to say, they appear again on the print outputs with an opposite sign in respect of the deviation of the optical density from the desired value.

### Objects of the present invention

It is an object of the present invention to provide a method for calibrating a thermal printer.

It is a further object to provide a method for improving the uniformity of a print output produced by a thermal printer that does not show the drawbacks of the prior art methods.

Further objects will become clear from the description given below.

### Statement of the invention

The above described objects are achieved by a

method of calibrating a thermal printer comprising a thermal printing head having a multiplicity of 'i' heating elements  $H_i$  comprising the steps of

- sequentially activating each of said multiplicity of heating elements by means of data  $I_{i,T}$  that are expected to cause each heating element to attain substantially the same surface temperature  $T$ ,
- measuring the surface temperature  $T_i$  actually attained by each heating element  $H_i$  that is activated by  $I_{i,T}$ ,
- generating for each heating element  $H_i$  a correction value  $M_i$  on the basis of the measured surface temperature values  $T_i$  so that said heating element  $H_i$  when activated by a data value obtained by correcting  $I_{i,T}$  by said correction value  $M_i$ , attains exactly said surface temperature  $T$ .

The uniformity of half-tone prints generated by means of a thermally operated printing method and a thermal printing head having a multiplicity of heating elements  $H_i$  can be improved by applying a method comprising the steps of

- a) Transferring an uncorrected data record  $I_{i,u}$ , corresponding to an array of pixels of said half-tone print, to a computing unit,
- b) generating corrected data  $I_{i,c}$  on the basis of the uncorrected data  $I_{i,u}$  and of correction values  $M_i$ , wherein said correction values are obtained by the steps of

- b.1) sequentially activating each heating element  $H_i$  by means of data  $I_{i,T}$ , that are expected to cause each heating element to attain substantially the same surface temperature  $T$ ,
- b.2) Measuring the surface temperature  $T_i$  actually attained by each heating element when it is activated by  $I_{i,T}$ ,
- b.3) generating for each heating element  $H_i$  a correction value  $M_i$  on the basis of the measured surface temperature values  $T_i$ , so that said heating element  $H_i$  when activated by a data value obtained by correcting  $I_{i,T}$  by said correction value  $M_i$ , attains exactly said temperature  $T$ ,

- c) Transmitting the corrected data  $I_{i,c}$  to the thermal head and printing.

It has thus been found that half-tone prints can be produced by means of a thermally operated printing method and a thermal head having a multiplicity of heating elements  $H_i$ , with well-corrected print non-uniformity in the direction of the thermal head, if the uncorrected image data record  $I_{i,u}$ , which corresponds to an image to be printed, is converted into a corrected data record  $I_{i,c}$  by means of a computing processor by converting

each data item  $I_{i,u}$  into the associated data item  $I_{i,c}$  on the basis of a set of density correction values  $M_i$ . The density correction values  $M_i$  are calculated on the basis of the surface temperature  $T_i$  which the respective  $i$ -th heating element of the thermal head assumes when the thermal head is controlled by means of a data record  $I_{i,T}$  that is selected in such a way that each heating element is heated approximately to the same surface temperature  $T$ .

A method for obtaining  $I_{i,T}$  values to be applied to each individual heating element in order to cause each of these elements to attain approximately the same surface temperature  $T$  will be explained furtheron in the description.

It is surprising that exclusive or predominant use of the surface temperature of the heating elements as a criterion for compensating print non-uniformity along the thermal head can be put into practice with great success. Variations in thermal or mechanical contact between the thermal head and receiving material, these variations having been discussed in many publications, for example also in US Patent 4,827,279, are therefore of minor importance for the occurrence of streak-like or band-shaped faults in half-tone prints produced by means of a thermally operated printing method.

Preferentially, the density correction values are generated in advance and off-line, for example in an in-factory calibration procedure. The density correction values are then stored in memory to be used when producing a printed image.

However, it would also be possible to generate these density correction values on-line during each individual printing process. This would require a dedicated construction of the printer which would allow a calibration unit to be positioned in front of the elements of the thermal head during calibration and to be swung away during actual printing of an image.

By the term 'half-tone print' is meant a reproduction of an original, which is defined in one or more colours and in which the colour intensity is defined in more than 2 gradations. Single-colour or 3-colour image originals in at least 256 gradations of colour intensity are particular examples.

Thermally operated printing processes that are relevant in the context of the present application are all processes for producing a half-tone print, in which the temperature prevailing at a specific point of time and at a specific point of the printing head is a critical variable determining the optical colour density in the printed image.

Examples of thermal printers and processes performed in these printers are:

- thermal sublimation printers, that is to say printers which utilize a dye transfer process in which a dye carrier material is positioned between the receiving material and the thermal head, pressed down and moved, together with the receiving material, past

the thermal head. When electrical power is applied to a specific heating element of the thermal head, this heating element heats up and brings about a dye transfer, whether by diffusion or by sublimation, from the dye carrier material to an image element ("pixel") of the receiving material. The optical density in this image pixel is a monotonic function of the temperature of the heating element and of the duration of this process.

- Direct thermal printers wherein a printing material is used that comprises a heat sensitive component or a mixture of two components that upon a heat activated reaction generate an image. Examples of such mixtures comprise a combination of a leuco dye and an acid or a combination of an organic silver salt and a reducing agent for silver.

An example of a receiving material is a reflecting or transparent material in sheet form. In a specific example the material has an edge length of between 40 mm and 2 m. Rectangular receiving materials with a smaller edge length of between 100 mm and 300 mm may be mentioned for preference.

Papers may be mentioned as examples of reflecting receiving material and polymer films, especially preferably films consisting of biaxially stretched polyethylene terephthalate, or polymer films of this type provided with additional coatings, are examples of transparent receiving materials.

Any type of digital computer may be used as a computing processor for carrying out the calculations according to the invention. The computer may be part of the thermal printer. Single-board microprocessors are preferred. It may also be expedient, in this case, to conduct the calculations, to be carried out for the method according to the invention, by means of distributed processors, for example with one processor for controlling the thermal head and for converting the uncorrected data record  $I_{i,u}$  into the corrected data record  $I_{i,c}$  on the basis of the already known set of density correction values  $M_i$  and a second processor for all the other control functions and calculations.

The data record  $I_{i,T}$  that is applied to the elements of the thermal head in order to enable measuring of the actual surface temperature they attain is preferably a signal which supplies the same heating power to each heating element as a time average. In the following this signal is called 'a power compensated signal' (denoted by  $I_{i,p}$ ). This signal can be obtained by applying the method described in European patent application 0 601 658.

Application of a power compensated signal provides a compensation for electrical non-uniformities between individual elements of the thermal head. Compensation for the non-uniform thermal behaviour of the head is obtained by application of the method of the present invention.

The method disclosed in the above-identified Euro-

pean patent applications is as follows.

First a measurement of the power dissipated by each element of the thermal head being driven by the same driving current is performed. Next a compensation is performed so that the power dissipated by each element becomes equal to an envisaged power value.

The compensation process comprises two successive steps. First the element in the thermal head which dissipates the minimum of the power dissipated by all elements is identified. Then a global compensation is performed. More particularly, for all elements the power is augmented by a value which is determined so that the power dissipated by the identified element (dissipating minimum power) becomes equal to the envisaged power value. This is performed by changing the pulse width of strobe pulses gating the data signal to the elements of the thermal head.

In the second step the power dissipated by each element is individually adapted so as to become equal to the envisaged power value. This second step is performed by skipping a number of pulses in the data signal applied to an element. Pulses are preferably skipped in an equidistant manner so that the averaged power value becomes equal to the envisaged power value.

The image data record  $I_{i,T}$  used is either the image data record  $I_{i,p}$  as explained higher or an image data record which is calculated from this image data record  $I_{i,p}$  and from previously obtained density corrections (during an iterative process).

A correction value  $M_i$  for an element  $H_i$  of the thermal head is calculated as follows.

First element  $H_i$  is activated by means of a signal value  $I_{i,T}$ . Then, the surface temperature  $T_i$  of that element is measured. This is performed for a number of elements of the head so that a number 'i' of values  $T_i$  are obtained. Next, the average value  $T_{av}$  of 'i' values  $T_i$  is calculated.

Then, the difference between measured value  $T_i$  in the element under examination and average value  $T_{av}$  is calculated. This value is indicated as  $\Delta T_i$ . Finally from a known relation  $P = f(T)$  between power and surface temperature, a correction value  $M_i$  is determined. The correction value is expressed as an increase  $\Delta P_i$  of the power applied to element 'i'.  $M_i$  is equal to

$$\Delta P_i = \Delta T_i \times \Delta P / \Delta T \quad (1)$$

wherein  $\Delta P / \Delta T$  indicates the increase of power required to obtain an increase of the surface temperature equal to  $\Delta T$ . The relation  $P=f(T)$  is either theoretically defined or experimentally obtained through measurement.

The correction values  $M_i$  can be applied to an uncorrected signal  $I_{i,u}$  to obtain corrected data to be fed to the thermal head. Corrected image data  $I_{i,c}$  are e.g. obtained by skipping pulses in the data path of a pulse-wise controlled thermal head. The number of pulses

that is to be skipped is determined by the values  $M_i$ .

Pulse skipping has already been described in European patent applications EP 601 658 and in EP 627 319.

Pulse skipping basically consists of a decrease of the number of pulses that would normally be applied to the driver of a given element of the thermal head in order to generate an envisaged density on a printing material.

It has already been explained that the number of pulses that is skipped is such that the time averaged power dissipated by an element is changed so that non-uniformities of electrical origin are compensated electrically (i.e. through control of the dissipated power in an element of the head instead of through control of the dissipation time).

In addition to the correction of electrical non-uniformities also non-electrical non-uniformities, for example non-uniformities that are due to the non-uniform thermal characteristics of the thermal head, can be corrected in the above-way.

Pulses are preferably skipped in an equidistant manner.

Pulse skipping will be explained in greater detail hereinbelow with reference to a specific embodiment of a pulse-wise controlled thermal head. The described example is only given as an example and is not limitative.

The recording head of a thermal printer comprises a number of individually energisable resistors (for example 4352). The head further commonly comprises shift registers each providing data signal values for the resistor elements. The output of each of the registers is applied via a latch register and a strobe controlled gating means to the drivers of the elements of the thermal head.

A single line of an image is printed by activating the elements of the thermal head during a number of successive strobe periods. The line time (period required to print a single line) takes for example 20 msec and is composed of 960 consecutive strobe periods.

When in a pixel of the image a given density is to be printed, then the corresponding element of the thermal head is activated during a number of said strobe periods.

Maximum density for example corresponds with activation during 960 strobe periods (no correction being applied). This is implemented by feeding the gate which is connected to the driver of that specific element of the thermal head consecutively with 960 logical '1' values.

The number and sequence of logical binary values to be applied to the driver of each element of the thermal head to print each line of an image is in the following called 'an image matrix'.

So, in an image matrix the data referring to an element having maximum density comprises 960 consecutive logical '1' values.

Likewise a density value 480 would be represented by 480 logical '1' values. The image matrix would for example comprise for that specific element 480 consecutive logical 'one' values followed by 480 logical '0' values.

According to the method described in the above patent applications, compensation for electric non-uniformities is implemented by first generating so-called power map. The power map is generated by measuring the resistor values, measuring the power dissipated by these resistors under predetermined operational conditions, determining the procentual deviation of dissipated power to the minimum dissipated power value (as has been described higher), and finally generating a power map on the basis of this information. Such a power map comprises for each element in a line and for each strobe period within said line either a logical 'zero' or a logical 'one'. The values in said power map are determined so that when a value in the power map is applied to an 'AND' logical gate together with the corresponding value out of the image matrix, a number of logical 'one' values in the data path are turned to zero.

The number of logical 'one' values that is turned to zero is such that the effective time averaged power dissipation becomes equal to a 'set' value.

So far this explanation only relates to compensation for electrical non-uniformities.

In case of non-electrical non-uniformities in the thermal head, a similar power map is generated that, when combined with the image matrix in the same way as described higher, has a similar effect on the non-electrical behaviour of the elements of the thermal head. The behaviour itself of the elements of the thermal head is not changed but the effect of such non-electrical non-uniform behaviour is compensated for.

This second power map is preferably combined with the first power map to generate a combined power map the values of which are applied to an AND gate together with the corresponding value out of the image matrix so as to generate compensated data wherein when compared with the original data signal pulses are skipped.

In the context of this application corrected image data  $I_{i,c}$  are thus obtained by skipping a number of pulses in the pulse wise signal representing uncorrected image data  $I_{i,u}$ . The number of pulses that is skipped is determined by the correction values  $M_i$ .

The surface temperature of the heating elements is preferably obtained by measuring the radiation power emitted by the respective heating element.

It is preferred that this measurement of the surface temperature takes place in a wavelength range of 1 to 20 micrometres.

To measure the surface temperature at one time one of the heating elements may be activated by means of a heating current. It is however preferable to activate a number of elements around an element under evaluation because in this way secondary temperature influ-

encing factors such as the heating of the substrate and the cooling via the heat sink are also taken into account.

Preferably the measurement of the surface temperature is carried out by means of a radiation detector movable parallel to the thermal head.

It is advantageous that the positioning of the radiation detector relative to the respective activated heating element takes place by means of automatic regulation.

A particular way of positioning the radiation detector comprises the steps of activating a number of elements in the thermal head on both sides neighbouring the element that will be examined, whereby the elements in the immediate neighbourhood of the element under examination are however not activated.

The detector is then moved parallel to the thermal head and from the detected surface temperature values the location of the element to be examined can exactly be deduced.

This particular method is advantageous in that (i) the positioning is not complex yet very accurate and (ii) care is taken to keep the introduction of additional thermal non-uniformities to a minimum.

#### Brief description of the drawings

Particular embodiments of the present invention as well as preferred embodiments thereof will be explained with reference to the accompanying drawings wherein

Figure 1 schematically illustrates a thermal printer, Figure 2 illustrates the positioning of a radiation detector.

#### Detailed description of the drawings

A general embodiment of the method according to the invention will be explained with reference to Figure 1.

Figure 1 shows a direct thermal printer generally comprising a rotatable drum 6 and a thermal head 5. A recording material 7 is secured between head 5 and drum 6. Drum 6 is rotated by a driving mechanism which is not shown and which continuously advances the drum 6 and the recording material 7 secured to the drum past a stationary thermal head 5. The head comprises a number of individually energisable heating elements arranged in a row.

During normal printing operation, an original image to be printed is transmitted as a digital image data record  $I_{i,u}$ , via the data transfer lead 1, to the image memory 2 of a thermal printer. The image information is transmitted line by line from this memory to the processor 3 of the printer and, is converted according to the correction values  $M_i$  determined in a calibrating step executed in advance and recalled from a memory 8, into the corrected image data signal  $I_{i,c}$ . This data signal is transmitted to the line memory of the thermal-head control electronics 4. Subsequently, the printing operation is

triggered in the thermal head 5 and the recording material is moved on mechanically by the amount of one line spacing. Thereafter, the subsequent line is read out of the image memory 2 and into the processor 3 and is continued in the same way.

During calibration, a calibration unit comprising an infrared radiation detector 9 and controlling and data processing electronic circuitry 11-13 is positioned in front of the thermal head 5 so that an activated zone of the thermal head is imaged onto the surface of the infrared detector 9.

The elements of the thermal head are controlled by means of an input signal  $I_{i,T}$ .  $I_{i,T}$  is determined so that a heating element that is activated by means of a value  $I_{i,T}$  roughly attains an envisaged temperature  $T$ . Preferably  $I_{i,T}$  is a power compensated image signal, which means that approximately the same heating power is applied to each heating element. The value of the signal applied to an individual element of the thermal head has thus already been compensated for non-uniformities of electrical origin as has been described higher.

Then, the surface temperature of an activated element is detected by means of the radiation detector and a correction value pertaining to the activated heating element is determined on the basis of the measured surface temperature  $T_i$ .

The actual measurement of the surface temperature of a heating element is preceded by a step wherein the detector is exactly positioned in front of the element under examination.

The positioning of the radiation detector 9 relative to the elements of the thermal head 5 is illustrated in figure 2 and works as follows. The radiation detector is mounted on a mechanism 10 which allows it to be shifted parallel to the row of thermal elements of the thermal head.

Individual elements of the thermal head are calibrated sequentially. For the purpose of positioning the detector in front of element 'i', this element as well as a number of elements on the right and on the left side of element 'i' are activated by means of a signal  $I_{i,T}$ . However, the elements immediately neighbouring element 'i' are not activated.

Then, the detector 9 is shifted past the thermal head while measuring the surface temperature of the thermal head. The signal generated by the detector is amplified by amplifier 11, converted into a digital signal by analog-to-digital convertor 12 and applied to a controlling processor unit 13. Processor unit 13 selects the measured value which corresponds to the location of an element of the thermal head in between non-activated neighbouring elements and controls the positioning of the detector 9 so as to be positioned in that location.

When the detector has been exactly positioned, a correction value is determined pertaining to said element. For this purpose heating element 'i' as well as a number of heating elements (for example 50 elements on each side of the element under examination) neigh-

bouring heating element 'i' are activated because in this way the influence of the substrate onto which the heating elements are mounted in the thermal head as well as of a heat sink can be taken into account.

It is evident that it would also be possible to activate only heating element 'i'.

The temperature of element 'i' is then measured by radiation detector 9 and a correction value  $M_i$  is determined by application of formula (1).

The above described positioning of the detector, measurement of the surface temperature and calculation of a correction value is performed for each element of the thermal head. Finally, calculated correction values  $M_i$  are stored in memory 8. The calibrating operation is thus concluded.

In the described embodiment the calibration is performed at the production stage. It would however also be possible to built the printer so that it has a built-in calibration station which is in front of the thermal head during calibration and is swung away during actual printing so that it becomes possible for the receiving material to be pressed down onto the thermal head. As has already been mentioned, this embodiment would allow on-line calibration in between actual printing cycles to be performed.

It may be advantageous to precede the calibration step and the measuring step by a step wherein the thermal head is cleaned (by means of for example alcohol, cloth..).

The thermal head on which the thermographic measurements have been performed possesses a silicon nitride layer of about 8 micrometres as a scratch-resistant coating. This material has extremely high absorption precisely in the wavelength range of 8 to 12 micrometres, the measuring range of the thermographic camera explained below. Despite this small layer thickness, extinction is already above 5. The characteristic thermal radiation of this object is therefore determined solely by the temperature of the silicon nitride layer.

The thermographic camera was the model 600 of Inframetrics, Billeria, MA USA, with a  $10 \times$  telescope lens as macrooptics. The instrument measures two-dimensional temperature distributions  $I$  in a temperature resolution of at least  $0.1^\circ\text{C}$ . In the configuration used here, a local resolution of less than 0.1 mm is achieved. Since the emission coefficient of the measurement object was not known sufficiently precisely, it was not possible to measure absolute temperatures, but only temperature differences.

The method according to the invention for the correction of print non-uniformities allows a constructively simple and operationally reliable implementation of the measuring unit. The assignment of the temperature measurement value and heating-element number is necessarily ensured by the sequential control. The requirements placed on the mechanical precision of the detection unit are reduced to the normal degree for precision machine building as a result of the regulation of

position by means of the amplitude of the measurement signal.

The calibrating step requires no activities by the operator and is independent of any fluctuations in quality of the receiving material.

## Claims

1. A method of calibrating a thermal printer comprising a thermal printing head having a multiplicity of 'i' heating elements  $H_i$  comprising the steps of

- sequentially activating each of said multiplicity of heating elements by means of data  $I_{i,T}$  that are expected to cause each heating element to attain substantially the same surface temperature  $T$ ,
- measuring the surface temperature  $T_i$  actually attained by each heating element  $H_i$  that is activated by  $I_{i,T}$ ,
- generating for each heating element  $H_i$  a correction value  $M_i$  on the basis of the measured surface temperature values  $T_i$  so that said heating element  $H_i$  when activated by a data value obtained by correcting  $I_{i,T}$  by said correction value  $M_i$ , attains exactly said surface temperature  $T$ .

2. A method for the production of half-tone prints by means of a thermally operated printing method and a thermal printing head having a multiplicity of heating elements  $H_i$  comprising the steps of

- a) Transferring an uncorrected data record  $I_{i,u}$ , corresponding to an array of pixels of said half-tone print, to a computing unit,
- b) generating corrected data  $I_{i,c}$  on the basis of the uncorrected data  $I_{i,u}$  and of correction values  $M_i$ , wherein said correction values are obtained by the steps of

- b.1) sequentially activating each heating element  $H_i$  by means of data  $I_{i,T}$  that are expected to cause each heating element to attain substantially the same surface temperature  $T$ ,
- b.2) Measuring the surface temperature  $T_i$  actually attained by each heating element when it is activated by  $I_{i,T}$ ,
- b.3) generating for each heating element  $H_i$  a correction value  $M_i$  on the basis of the measured surface temperature values  $T_i$ , so that said heating element  $H_i$  when activated by a data value obtained by correcting  $I_{i,T}$  by said correction value  $M_i$ , attains exactly said temperature  $T$ ,

- c) Transmitting the corrected data  $I_{i,c}$  to the

thermal head and printing.

3. Method according to claim 1 or 2, wherein the surface temperature of the heating elements is obtained by measuring the radiation power emitted by each of the heating elements. 5
4. Method according to claim 1 or 2, wherein surface temperatures are measured by a detector measuring in the wavelength range of between 1 micrometre and 20 micrometres. 10
5. Method according to claim 1 or 2, wherein data  $I_{i,T}$  used for activating the thermal head for measuring the surface temperature supplies the same heating power to each heating element as a time average. 15
6. Method according to claim 1 or 2 wherein said image data  $I_{i,u}$  is represented for each pixel by a pulse signal and wherein said corrected image data  $I_{i,c}$  is obtained by skipping a number of pulses in said pulse wise signal, said number being determined by said correction values  $M_i$ . 20

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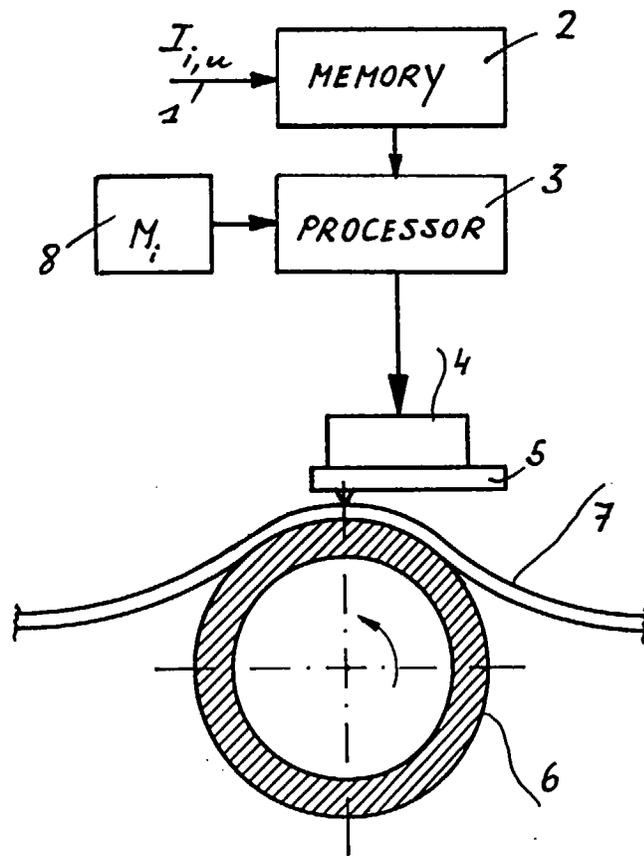


FIG. 1

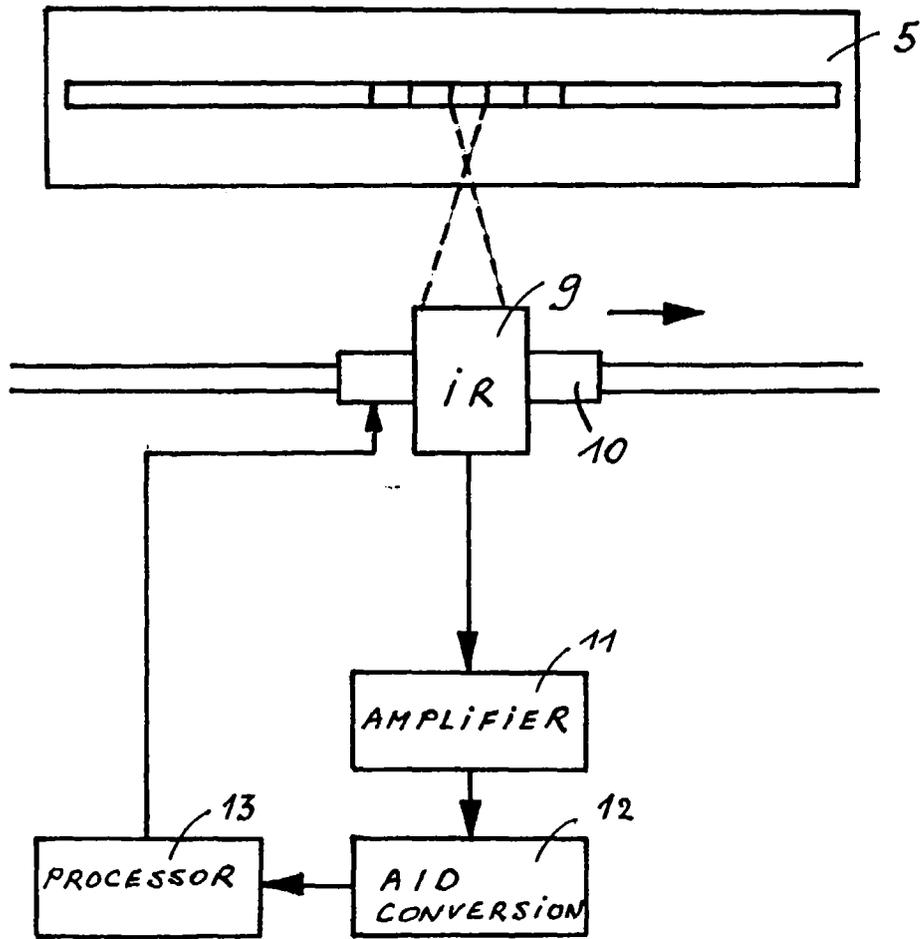


Fig. 2



European Patent Office

EUROPEAN SEARCH REPORT

Application Number  
EP 96 20 2801

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 440 (M-1310), 14 September 1992 & JP 04 152151 A (OKI ELECTRIC IND CO LTD), 26 May 1992, * abstract *	1,2	B41J2/36
Y	---	3,5,6	
A	PATENT ABSTRACTS OF JAPAN vol. 018, no. 335 (M-1627), 24 June 1994 & JP 06 079906 A (HITACHI KOKI CO LTD), 22 March 1994, * abstract *	1,2	
D,Y	--- EP 0 627 319 A (AGFA-GEVAERT NAAMLOZE VENOOTSCHAP) * the whole document *	5	
D,Y	--- EP 0 601 658 A (AGFA GEVAERT NAAMLOZE VENOOTSCHAP) * the whole document *	6	
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			B41J
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		14 March 1997	Meulemans, J-P
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